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LARGE-SCALE MAPS AS GEOGRAPHICAL ILLUSTRATIONS.

VERBAL descriptions are so insufficient in geographical teaching that supplementary illustrations, in the forms of maps, views, and models, must be employed as far as possible. As an aid towards making a collection of the first class of these illustrative materials, this essay gives an account of a number of examples from a collection of grouped sheets of foreign large-scale topographical maps that have been used in my college course in Physical Geography — Physiography — with much profit during recent years.

The ordinary wall and atlas maps, on a scale of 1–1,000,000 or smaller, show large parts of the world and suggest the general location of one geographical feature with respect to another; they give much general information, but they afford no sufficient indication of topographical form. Land relief is so far generalized on such maps that its conventional representation hardly recalls the image of land forms as we actually see them outdoors. The detailed governmental maps, on the other hand, on a scale of 1–100,000 or larger, show so small an area of country that their location can at first be hardly identified, unless they happen to include some well-known city, or river, or other familiar feature ; they must generally be located by means of an ordinary small-scale map which designates their area with respect to known boundaries. But these maps represent so much topographical detail that an examination of them really gives a good idea of the actual minute forms of which the land surface is made up ; and they thus supply a basis for geographical observation that is in the highest degree profitable to the student or investigator. They are in effect so many new texts, in graphic instead of in verbal form. Some practice is necessary in order to interpret their meaning easily and accurately ; but their language is not difficult to learn. Next to a visit to different parts of the world, the study of these maps presents the best opportunity of gaining a real sense of the facts of geographical form with which Physical Geography has so largely to deal. In so far as they enable the student rapidly to generalize the individual facts slowly accumulated and recorded by many observers, they endow him with a power that could not be gained by field work without their aid, except by spending a very long time on the ground.

This value of good maps is evidently not generally recognized or admitted, but it may be claimed and defended. It is as legitimate to base scientific discussions of fact and theory on good maps as it was for Loomis to base his great series of meteorological inductions on the records of our Signal Service. The failure to perceive this is indicated in a recent notice of an essay by C. Abbe, Jr.,[1] in the Monthly Record of the (London) Geographical Journal for March of this year. Mr. Abbe's essay dealt with the features and the explanation of the cuspate capes of our Carolina coast, his statement of fact being based on the Coast Survey charts. The explanation or theory of the origin of the cusps was entirely distinct from his inductions of generalized facts. The reviewer in the monthly notices, however, says: This essay appears to be "a purely theoretical discussion, not based on actual observations." Truly it was not based on *personal* observations, but it was very carefully based on *actual* observations ; and in this respect it was, to compare small things with great, not "purely theoretical," but as truly scientific as Loomis' famous studies.

The habit of using maps, as far as travelers generally possess it, is very largely based on familiarity with atlas maps, as studied in the school room or library ; and it is perhaps for this reason that explorers are so often content to bring home only narrative or locative accounts of their experiences, and so generally satisfied to omit the systematic, rational, explanatory

[1] Proc. Bost. Soc. Nat. Hist., XXVI, 1896, 489–497.

descriptions of the geographical forms that they have seen. The use of large scale maps in teaching may perhaps in part serve to correct this bad habit.

The maps that I shall here refer to are prepared by governmental surveys of European countries. These foreign maps are in general of greater detail and accuracy than those of our country, but of course the latter should not be neglected. They are of great educational value and are in constant use in my teaching, as is more fully indicated below. The use of the foreign maps began with selections from the sheets of the Ordnance Survey of Great Britain and of the Army Staff map of France in our college library. At first the separate sheets were carried to the geographical laboratory and hung in groups on the wall or on racks. But there was much trouble in carrying the sheets back and forth, and in hanging them up in proper order; the white margins of the adjoining sheets prevented their joining nicely, and the constant use of the same sheets, year after year, threatened to injure them more seriously than could be permitted. I have, therefore, in recent years devoted part of the fund allotted for laboratory expenses to the purchase of extra copies of the particular sheets that give the best illustrations, and it is the grouped sheets thus selected that are in part described below. By mounting the sheets in groups on rollers they can be kept on racks in the laboratory, easily hung on the wall when wanted, and quickly stowed away again when done with. The ease of handling thus gained is one of the best means of increasing the use of maps as materials for laboratory instruction in geography. The labor of preparing for an exercise and clearing up the room after it must be reduced to a minimum, especially for those of us not liberally endowed with the spirit of order; otherwise too much time is taken in purely manual work, if indeed the trouble of such work does not lead to its neglect altogether.

The mounted sheets have served so good a purpose that I am now increasing their number as rapidly as possible. They serve not only in the general course in which the principles of physiography—geomorphology, some of our writers would call it—are treated, but they are invaluable in a later course on Europe, where forms that were before considered chiefly as types of their kind, are considered more fully in their relations to their surroundings, and in the controls that they exert on occupation and movement; but of this later use it is not my purpose to say more at present. The selection of sheets to be purchased for the laboratory is in all cases made from the full set, as far as published for each country, in the map collection of the college library; this collection having been at my intercession largely increased in the past four years. Practically all the European countries are now represented on scales varying from 1–40,000 to 1–100,000. Details concerning the manner of preparation and the form of publication of all the maps may be found in Wheeler's compendious Report on the Third International Geographical Congress and Exhibition at Venice, 1881, published by resolution of Congress as House Ex. Doc. No. 270, second session, Forty-eighth Congress, Washington, 1885. Small index maps, showing the distribution of completed sheets of the modern topographical surveys of the European countries, are very conveniently published in the *Geographisches Jahrbuch* (Gotha) for 1894.

The grouped sheets provide for foreign countries much the same illustrations as are given of our own country by our governmental maps, of which a list of selected single sheets, useful for purposes of study and teaching, was prepared at the suggestion of the Geographical Conference held in Chicago in Christmas week, 1892, and published under the title "Governmental Maps for Use in Schools" (Holt, New York, 1894). There is, however, a marked difference between the home and foreign maps in the much greater detail of the latter. It is true that the maps of our Coast Survey are not excelled for minuteness of detail by any of the foreign maps here referred to; but the Coast Survey charts cover only a narrow border of land along the seashore. The topographical maps of the United States Geological Survey are less detailed; they are truly a great advance on anything that we before possessed for the greater part of the country that they cover, but they are by no means of final accuracy. Indeed, one of the results that I hope to see from their publication is the education of the public to the need of still better maps and their preparation a few decades in the future. For the present it is perhaps too much to expect that so vast a domain as ours can be surveyed in a manner appropriate to more densely settled European countries, and at a cost that might in many regions approach the market value of the land itself. Information as to this question of relative cost may be found in Wheeler's report, above mentioned, and in the testimony of Major Powell, then director of the United States Geological Survey, before the Joint Commission of Congress on the Governmental Scientific Bureaus in 1884–5 (XLIX Congress, 1st session, Mis. Doc. 82, Washington, 1886).

It is not intended to imply for a moment that better examples of geographical forms are to be found abroad than at home; but that, for the present, better representations of many typical forms can be obtained from foreign than from home surveys. Care should of course be taken to introduce home examples as fully as possible; and for this purpose, a good number of our own maps, grouped and mounted for laboratory study, are in frequent use, and their number is increasing year by year; but there are two lessons that are well taught by the foreign maps. The first is the essential community of individual geographical forms over the world; when well learned in one place, they may be easily recognized in another. The similarity of members of the same family is very striking, and gives good emphasis to the principles of systematic geography. The second lesson concerns the educational value of fine maps; from this I hope in time to see a growth of public sentiment in favor of better maps for our own country, and where should this sentiment be planted better than among college students?

The intelligent appreciation and use of good home maps will be furthered by a knowledge of the kind of information that good foreign maps impart. At present it is seldom that one notices a traveler, among the thousands who travel, furnished with a map of the district that he is traversing, even though it may be unfamiliar to him. The railroad diagrams, given on time-table "folders," are hardly to be reckoned among maps, as they are nearly always greatly distorted for the sake of bringing the line and the stations of the company that publishes them distinctly before the traveler's eye. Moreover, they omit nearly all indication of physical features; any sign of relief that is introduced is badly drawn. Yet a good map greatly increases the pleasure and diminishes the fatigue of travel to one who is intellectually active enough to take interest in novel surroundings. The name of a river and its course up and down stream, the places that are near but not on the route followed, the further extent of physical features that are partly in sight from the car windows; all these matters deserve recognition at the time of passing them. A student who has had some experience of really good maps will go further than simply supplying himself with the best maps he can now find of his line of travel; he will be so discontent with those that he can ordinarily get in this country that he will contribute towards building up a demand for better maps.

These grouped sheets are simply invaluable in teaching. Students and visiting teachers alike are so ready in their appreciation and praise of them as materials for geographical teaching that I urge the introduction of their use by all who wish to make vivid impressions of the fundamental facts of the science of geography. At a later date the examples here given will be supplemented by briefer accounts of others from Norway, Sweden, Austria, Italy, etc.

The following accounts of a number of grouped sheets are arranged according to countries, rather than according to the features that they represent, as the former plan seems more convenient for the use of teachers and students to whom this paper is addressed. At the beginning of the series for each country is the official name of the survey from which the map sheets are taken, the scale and general style of the map, the dimensions and cost of single sheets, and the name and addresses of the government agent from whom they may be bought. Many additional details concerning these surveys, their date of beginning and ending, their officers, administration, cost, and so on, may be obtained from Wheeler's report, referred to above. Each group of sheets is given a distinctive local name for easy reference; this being followed by the official numbers of the sheets selected. Orders for copies of these sheets can be sent through any importing bookseller; but it is important to emphasize certain points. The edition on the lightest paper should be selected, when there is any variation in this respect. Particular care should be taken to pick out sheets that match in tint of paper and in depth of impression in printing; otherwise, the several sheets may not match well when mounted together. Blank index maps of each country should be asked for; these are generally furnished free or at nominal cost, and are of value in giving precise location to the group of sheets when mounted. The cost of mounting is often nearly as much as the cost of the maps; but it is essential to have this work well done.[1]

GREAT BRITAIN.

ORDNANCE SURVEY OF SCOTLAND. Scale, one inch to a mile, 1:63,360; "with hills." Sheets, 24 by 18 inches, printed in black, with hill shading in harchures; altitudes of various points given in feet.

NEW ORDNANCE SURVEY OF ENGLAND. Scale, printing, etc., same as the above but sheets of smaller size, 21 by 16 inches. The original ordnance survey has much less expensive hill shading than the new survey, but the new sheets at present cover only a small part of the country.

Sale Agent. Edward Stanford, Charing Cross, London, S. W. Price, per sheet: Scotland, 1s. 9d.; England, 1s.

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[1] MESSRS. W. W. WHITE & CO., 66 Pearl street, Boston, have done a good deal of this work for me in a thoroughly satisfactory manner.

THE SCOTCH HIGHLANDS AND THE GREAT GLEN.

Sheets 53, 54, 62, 63, 72, 73, 82, 83.

The Highlands of Scotland are described by Sir Archibald Geikie in his Scenery of Scotland (2d edition) as an ancient mountain region, reduced to a plain of moderate inequality by atmospheric and marine denudation, and then broadly elevated and dissected. Since the dissection, the region has been heavily glaciated and moderately depressed; thus the lochs and the fiords are explained; Professor James Geikie's *Great Ice Age* (3d edition) being the best reference on this part of the subject.

The group of sheet here selected includes the western part of the Grampian Hills (the Highlands next north of the Lowlands), as well as part of the more northern Highlands and of the Great glen by which the northern and southern Highlands are obliquely separated. The chief characteristic of this rugged region is the thorough, mature dissection of the ancient peneplain in which the glens are carved, and the absence of definite trends in the course of the smaller ridges and glens. It seems as if the structure of the uplifted plain of denudation were so massive that the processes of dissection in the present cycle of erosion found few distinct guides to direct their course. The Great glen, which is said to follow an ancient structural line of deformation and weakness, is almost the only example of topographic form that persists in maintaining a definite course for a considerable distance.

Among the special features of this region may be mentioned: Ben Nevis, the highest of the Scotch summits, although only about four miles from the head of Loch Linnhe, a long arm of the sea that enters far into the trough of the Great glen; several straths, or broad valley floors, such as Straths Spey and Spean, the seat of the greater part of the scanty Highland population; the frequent low level and comparatively flat divides on glen or strath floors between opposing streams; several large lakes, such as Lochs Lochy and Ness in the. axis of the Great glen, with Quoich and Arkaig on the north and Treig and Etive on the south in subordinate glens, all these and their fellows being ascribed to glacial excavation by Scotch geologists; diluvial and alluvial valley floors, the first at the head of Loch Carron, consisting of a wash of gravels in front of a local terminal moraine, the second in Glen Glass, traversed by a meandering stream; numerous small rock-basin lakes in corries or cirques at the head of steep-sided glens, and many scattered tarns on the more even upland surfaces; the famous "parallel roads" of Glens Roy and Gloy, just north of Ben Nevis, the relation of the altitude of these beaches to the controlling cols being clearly shown (a list of articles on this interesting locality may be found in *Nature* for May 20, 1880); the peculiar back-handed courses of the streams on the southern side of Strath Spean, strongly suggesting a modification of preglacial divides by glacial erosion and deposition, although not yet locally studied and explained as far as I have been able to learn; the upper part of Loch Linnhe, one of the finest of the sea-lochs, or fiords, by which the western coast is so deeply indented; the twenty-foot sea bench occurs around the shore of this loch, all the villages, roads, and crofts being laid upon it; but it is too delicate for clear representation on these maps.

It should be noted that western Scotland is a good example of a too irregular coast line. The submergence suffered by the western coast has drowned the lower ends of many straths, converting them into fiords, whose waters rise on the steep slopes of the mountain sides; thus the area of easily habitable ground has been unfortunately decreased. A great number of the protected harbors might be to advantage exchanged for low ground on which the harbor-users could live. A highly irregular coast line is not alone an advantage to human development; it must be well proportioned to other advantageous features, as Ratzel has shown (Jahresber. Geogr. Gesell, München, 1894, 83).

THE EASTERN LOWLANDS OF SCOTLAND.

Sheets 23, 24, 31, 32, 39, 40, 47, 48, 55, 56.

The lowlands have been denuded in Tertiary time on a belt of comparatively weak strata (Old Red and Carboniferous, rich in coal and iron,) between the more resistant rocks of the Highlands on the north and Southern Uplands on the other side. This series of sheets exhibits on the north the border of the eastern Grampians, which repeat the systemless, trendless forms of the Ben Nevis region; the sudden descent to the Lowlands, where the tilted rock structure produces well defined ridges of moderate height—not to be confused however with the numerous drumlins of smooth-flowing form and arrangement and of small elevation. The chief ridges are the Ochils, the Sidlaws, and the Pentland hills; these being resistent interbedded igneous rocks, Carboniferous for the most part, that have withstood the erosion of Tertiary time. The river Tay, emerging from the Grampians on the north, breaches the Sidlaws at Perth, and then turns eastward and follows the axis of the anticline, whose flanks form the Sidlaws on the north and eastern Ochils on the south to its estuary at Dundee. The Forth, breaching the Ochils at Sterling, turns eastward through its estuary or Firth in the broad depression between the Ochils and the Pentland Hills. To the southeast of Edinburgh, the preglacial surface of the Lowland appears to have been less degraded than aggraded by glacial action, for the district is completely fluted with drumlins. The smaller streams hereabouts all follow narrow postglacial channels

The Southern Uplands rise in the Lammermuir group; irregularly dissected, but of much less relief than the Highlands, and generally with smoothly flowing forms.

The most important matter to emphasize in connection with this group is that the moderate altitude of the Lowlands is not due to failure of uplift hereabouts of the ancient lowland of denudation which embraced all Scotland; the district of the Lowlands was uplifted with the Highlands on the north and the Uplands on the south; but while the Highlands and Uplands have, in virtue of their resistant rocks, retained in their skylines good evidence of the altitude to which their entire surface formerly rose, the Lowlands, of relatively weak rocks, have wasted away and as a whole are reduced to an imperfect peneplain of the second generation. It is only where the more resistant volcanic rocks occur among the weaker sedimentaries that a significant part of the altitude that the whole Lowland district once had is still recognizable. In all this, the Lowlands are much like the broad lowland of the Connecticut valley in Massachusetts and Connecticut, between the uplands of the New England plateau on the east and west; even to the occurrence over the valley lowland of ridges of volcanic rocks, whose crest lines almost reach the altitude of the enclosing uplands.

It is also important to note that the depression, by which the valleys were drowned into fiords in the Highlands, caused the Lowlands to suffer a general decrease of breadth as well as a penetration by firths. Thus a considerable area of valuable ground was lost, not only for easy agricultural occupation, but also for the industrial pursuits connected with coal and iron industries, here so highly developed.

NORTHERN ENGLAND.

New one-inch maps, "with hills;" sheets 23–27, 29–34, 38–44, 48–54; these sheets had better be mounted in two groups, an eastern and a western.

This series presents a topographical section across northern England. On the west are the revived ancient mountains of the Lake district of Cumberland and Westmoreland, with their radial valleys. Here, as in the Scotch Highlands, structure has little influence on topography; the ridges are trendless and the dissection about mature. The delta-heads in Derwentwater, Windermere, and other lakes, the delta division of Buttermere and Crummochwater, and of Derwentwater and Bassenthwaite, and the meadows of small obliterated lakes of the Esk, Great Langdale, etc., are all easily recognizable. (See H. R. Mill, Bathymetric Survey of the English Lakes. London Geogr. Journal, V. 1895, 46–73, 135–166.)

The vale of Eden (Trias) separates the highlands of the Lake district from the strong escarpment of the Pennine chain (Carboniferous) on the northeast; but further south, the two highland areas merge. The vale of Eden is floored with drumlins of large size and excellent form, trending northwest. The

Pennine escarpment of Durham and Yorkshire marks the edge of an eastward monocline of Carboniferous strata, faulted on the western slope, deeply scored by short valleys opening westward and by longer valleys descending eastward. The divide between these two systems of drainage offers an interesting line for study.

The rugged hills of Yorkshire gradually decrease in height and merge into a lowland of Triassic strata, the northern extremity of the long irregular "inner lowland" by which the "oldlands" of Yorkshire, Wales and Cornwall are separated from the double scarped ancient coastal plain of the eastern and southeastern counties. Portions of the infacing scarps of the Yorkshire moors (Oölite) and the Yorkshire wolds (Chalk) are included in the southeastern sheets of this group, exhibiting the systematic arrangement of consequent, subsequent, and obsequent drainage lines that characterizes the whole extent of the ancient coastal plain, from its beginning in Yorkshire southward to the English channel, as discussed in my paper on the Development of Certain English Rivers (London, *Geographical Journal*, V, 1895, 127–146). At their northern termination, the longitudinal features of the ancient coastal plain abnormally turn eastward and are cut across in succession by the shore line, instead of continuing parallel to it, as in the normal arrangement of such forms: Flamborough head and the cliffs of Whitby present sections of the Chalk wolds and the Oölite moors.

Ramsay's Physical Geology and Geography of Great Britain (6th ed.) and Woodward's Geology of England and Wales (2d ed.) are the most accessible sources of information for this district and for England generally, but they give little physiographic detail compared to Geikie's admirable book on Scotland.

The central and southern part of England has not yet been covered by the new Ordnance Survey, and the hill shading of the older Survey is so inexpressive and often so uneven that no other groups for England are at present recommended. When issued, the sheets for the *Weald* (new series, 269–274, 285–290, 301–306, 317–321, 332–334) will be very instructive.

FRANCE.

CARTE DE FRANCE DE L'ETAT MAJOR.—Scale, 1:80,000. Printed in black, with hill-shading in hachures; altitude of various points in meters. Sheets about 19 by 31 inches; may be bought in quarter sections.

Sale agent.—L. Baudoin, Passage Dauphine, 30, Paris. Single sheets, 4 fr.; quarter sheets, 1.20 fr.

THE SEINE IN NORMANDY.

Sheets 19, 20, 30, 31.

This part of Normandy is chiefly a gently undulating upland, dissected by numerous adolescent valleys. Although the Cretaceous (Chalk) and Tertiary strata of the region are, for the most part, nearly horizontal, the upland does not appear to be an initial, undenuded plain, inasmuch as geological studies indicate a considerable denudation as having occurred hereabouts. Whether the upland is a structural plain (a plain formed by the removal of overlying weak strata and the discovery of a more resistant stratum on which further denudation hesitates) or a peneplain of a former cycle of denudation, now elevated and again undergoing dissection, does not appear to be fully determined; but I am inclined to take the latter view, from the peculiar behavior of the river Seine, as well as from the features of the district known as the *Pays de Bray*.

Although the Seine is enclosed in a valley of steep-sloping sides, this beautiful river swings in large curves of notable regularity, exhibiting the *méandres encaissés* of La Noë and Margerie (Les Formes du Terrain, Paris, 1888, 68). It seems to exhibit in these systematic meanderings the habit of maturity or old age, although the steep slopes of the valley sides would not indicate a later stage of development in the present cycle than adolescence. The current explanation of this relation suggests that the habit of meandering was normally acquired by the river during the late stage of a well advanced earlier cycle of denudation, and that the habit was preserved during and after the even uplift by which the present cycle was initiated. In common with many other examples of this kind, the meander belt (the belt of country included between a pair of lines tangent to the outside of the meander curves) seems to have widened from the measure that it possessed at the close of the former cycle; the evidence of this being found in the more gentle slopes by which the convex lobes of the upland descend into the meanders; while on the opposite side of the river, the descent from the upland to the river's bank is abrupt. The stream has therefore not cut its present valley vertically beneath its former path, but has swung out somewhat to the right and left at its convex turns, encroaching on the plateau on either side, and prolonging the lobes of the upland that descend into the meander curves. A special bit of evidence for this supposition is found at the village of Duclair, some eight miles west of Rouen. Here a small stream, coming from the upland on the north, formerly continued its way through a southward lobe to the next down-stream curve of the Seine; but the ridge that separated the stream from the Seine has now been cut through by the northward encroachment of the meandering river, and for this reason the stream now mouths in the Seine several miles above its former mouth; its abandoned lower valley appearing as a narrow trench running obliquely through a lobe of the upland.[1]

The Pays de Bray is shown in great part on sheets 20 and 31. Structurally, it is a torn anticline, trending and plunging northwest and southeast, with a fault on the northeast side. Now deeply denuded, it determines a series of low ridges and shallow valleys, arranged in the form of a strung bow, with upper Jurassic strata revealed in the space between the bow and the string. The great initial elevation of this anticline is now well beveled down to an altitude on its ridges of a little over two hundred meters, and this accords so well with the general altitude of the Chalk and Tertiary uplands hereabouts, that the ridges of Bray confirm the evidence drawn from the meanders of the Seine as to the two-cycle, composite topography of the region. Sheets 11 and 32 include the extremities of this interesting and exceptional deformation. The trend of its anticline carries it northwest towards the Isle of Wight, and suggests its association with the sharp upturn by which the Chalk is revealed on the southern side of that island.

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[1] This accident and certain features of the next two groups of maps are moer fully described in an essay by the author on the Seine, the Meuse, and the Moselle, Nat. Geogr. Mag., June and July, 1896; the same appearing in French in the Annales de Géographie (Paris), V, 1895, 25–49.

The upland on either side of the Seine exhibits the features of adolescent dissection in the most characteristic form. The digitate valleys, although narrow and steep-sided, have well-graded floors. Much uncut upland still remains between the headwaters of the streams, yet the form and arrangement of the valleys immediately suggests the active headwater extension of every little branch. Some of the roads and railways follow the chief valleys; others traverse the upland, systematically avoiding the valley heads; still others ascend one branch valley, cross the upland and descend another valley. The larger cities are in the chief valleys; but the upland has many villages and is very generally occupied. The steeper valley sides are commonly forested.

The lower course of the Seine is now entered by strong tides, as if the region had suffered a slight depression since the excavation of the valley. The flood tide enters the estuary as a bore or mascaret, best seen at Caudebec, about midway between Havre and Rouen. The tidal scour seems here to have greatly aided the normal action of the river in widening its valley floor. While the convex lobes of the upland that enter the meander curves above Rouen still retain their normal form and allow only a narrow flood plain to the river, those that enter the valley further down-stream are in many cases reduced to acuminate or blunt cusps; the production of these cusps by the gradual consumption of the original lobes being clearly indicated by the transitional forms seen in regular order on passing down the valley, and by the manner in which the cusps point into great concave amphitheaters on the opposite side of the valley. Three examples of this kind about Quillebouef are beautifully shown.

Further down, the valley has been more widened, forming the present estuary; here all traces of the (presumable) primitive lobes and meanders are destroyed. Thus, to a very limited extent, the action of marine currents in excavating valleys, generally accepted as the sole process of origin early in this century, still deserves consideration in the lower valley of the Seine.

The coast of this region gives a remarkably good example of a long continuous sea cliff, of very moderate irregularity, in the production of which the original outline of the land has been completely destroyed. This is the best example of a thoroughly simplified, mature coast line that I have found. The recession of the coast has been so great that the lower trunks of a number of small rivers have been consumed, leaving the upper branches now to enter the sea as independent streams. Rivers of this kind may be said to be "betrunked" by marine erosion; they are easily distinguished from rivers that are betrunked by submergence. The smaller valleys are cut across in mid-height on the cliff face; their deepening not having kept pace with the recession of the cliff, in spite of the strong fall at their lower end. The large proportion of underground drainage through the chalk of the upland has probably much to do with this result.

Villages on the coast are found only where the larger streams have deepened their valleys to sea level. St. Valéry-en-Caux and Fécamp are good examples. Between these valleys, the cliffed coast is absolutely harborless and inaccessible. Jetties are constructed at the valley-mouths to keep the stream-inlets clear; but they are rapidly clogged with the shore drift of chalk flints.

THE CHAMPAGNE.

Sheets 33, 34, 49, 50, 66, 67.

The lowland of the Champagne lies on the Cretaceous formation, enclosed by the Tertiary escarpment of the Ile de France on the west, and descending by a lower escarpment of chalk to the humid Champagne belt on the east.[1] The strata are gently inclined to the west; they form part of the great Mesozoic-Tertiary basin of northern France, whose "oldland" is outlined by the Ardennes on the north, the Vosges on the east, and the Central plateau on the south.

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[1] An excellent account of the physiography of this region is given by de Lapparent. Leçons de Géographie physique, Paris, 1896, 396.

About eighty miles east of Paris, the Marne, one of the chief branches of the Seine, flows across the calcareous lowland of the Champagne, past Châlons and near Rheims, and enters the arenaceous upland of the Ile de France. The valley of the river then abruptly changes from a broad flood plain, lying openly on the rolling low country, to a comparatively narrow trench enclosed by steep slopes from the upland; but as the upland loses height to the west with the dip of the Tertiary sandstones which maintain it, the depth of the trench decreases. About forty miles south of the passage of the Marne, the Aube-Seine traverses the same calcareous lowland and enters the same arenaceous upland. Between the two rivers, and to a certain distance further north and southwest, runs the strong escarpment or *inface* of the Ile de France. Its slope is very largely covered with vineyards, which supply the great wine-cellars of Epernay and Rheims. The prospect from the crest of the inface is a most delightful one. Considering all these features together, it appears that this group of sheets presents a striking example of an ancient coastal plain, whose oldland lay to the eastward, whose strata dip gently westward, and whose existing form exhibits a well-developed longitudinal arrangement of topographical features, in contrast to the transverse arrangement frequently observed. It may be noted by the way that the Brandywine, Prince Frederick, Wicomico and Leonardtown (Maryland) sheets of the United States Geological Survey illustrate the form of an almost maturely dissected coastal plain with transverse features, slightly complicated at present by standing "up to its ankles" in the Atlantic, and thus drowning its valley floors into long narrow arms of the sea. On the other hand, the inner part of the coastal plain of Alabama is an excellent example of a plain having longitudinal features, parallel to its shore line; the Chunnenugga ridge corresponding to the upland

and escarpment of the Ile de France, and the inner black-soil prairies of the cotton belt representing the lowland of the Champagne. The longitudinal arrangement of relief is in these cases entirely due to the occurrence of a more resistant stratum overlying a less resistant stratum. On such a structure, the normal succession of features developed in the mature stage of dissection — especially in the mature stage of one cycle following the old age of a previous cycle — is the *inner lowland*, where the weaker strata are worn down to faint relief; the *inface*, where the retreating margin of the overlying group of harder strata now stands; and the *outlooking slope*, bevelling down the back of these harder strata to the next group of weaker beds, or to the coast. No name is yet suggested for the longitudinal upland that embraces both the steep infacing and the gentle outlooking slopes. The term "ridge" has been used, as in Clark's account of the Cretaceous formations of New Jersey, but ridge is rather too emphatic for so broad and gentle an elevation as the uplands of this kind often present; and, moreover, ridge is a term of general application. What is needed is a term that shall be associated with the upland formed by a resistant stratum of gentle dip as distinctly as inface is coming to be associated with the inland facing escarpment of the upland.

The district between the two master rivers, the Marne and the Seine, is very instructive in exhibiting a number of beheaded and diverted streams, such as are generally characteristic of the inner lowland of coastal plains having longitudinal features. No more perfect and symmetrical example of the kind has come to my notice. It may be explained as follows:

At a much earlier stage of topographical development than the present, and before the weak calcareous belt was excavated to a significantly lower level than the harder arenaceous belt, three other streams ran westward between the Marne and the Aube-Seine. These streams may be called the Surmelin, Petit Morin, and Grand Morin, after the names of their present lower courses. The middle of the three forked into two branches, the Somme and the Vaure, just east of the line between the calcareous and arenaceous belts. Since then, all the streams have deepened their valleys. The master rivers have cut down to the greatest depth. The three intermediate streams have cut down to a less depth. From all these deepening valleys subsequent side-streams have grown out, roughly following the strike of the weak calcareous belt; but the most active and important of these belong to the two master rivers. Let us then consider particularly two of these subsequents; one growing southward from the Marne, the other northward from the Aube-Seine. These master subsequents long ago beheaded the Surmelin and the Grand Morin, diverting their upper courses, the Soude and the Maurienne, to the appropriate master rivers, and leaving the upper part of their beheaded lower courses in shallow valleys on the sandy upland. The escarpment has probably retreated two or three miles since these captures, and obsequent[1] streams now drain the area between the inface and the subsequent streams. The rearrangement of drainage, however, has not stopped at this point; each master subsequent stream, continuing its headward growth, has acquired in the most symmetrical manner one of the two forks that once belonged to the Petit Morin; the northern of the forks (the Somme) now flowing northward to the Marne; the southern of the two (the Maurienne) southward to the Aube-Seine; the distance from the elbow of capture to the master river being almost the same in the two cases. Inasmuch as a long time must have elapsed between the early beheading of the Surmelin and the Grand Morin and the later beheading of the Petit Morin, the latter stream had time enough to cut a valley of considerable depth through the upland before it was beheaded. But now, in consequence of its loss of volume by the diversion of its headwater forks, its diminished lower course is embarrassed by the rock waste that creeps down the slopes of its steep-sided valley in the upland, and hence its present head is converted into a marsh—the *marais de St. Gond*—for several miles. Here a local peat deposit has been formed; it is now excavated for fuel, thus giving a small economic value to this peculiar stage of river development.

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[1] See (London) Geographical Journal, V, 1895, 134.

While the considerable length of the two obsequent streams near the elbows of the Soude and Maurienne indicates the lapse of a long time since the Surmelin and the Grand Morin were beheaded, the absence of any perceptible obsequents at the elbows where the forks of the Petit Morin have been captured shows that these last changes have been very recently accomplished; the only perceptible alteration since the capture being a slight trenching of the rearranged stream-lines below and above the elbows. The more active degrading action of the diverted streams and the distinct aggrading action of the beheaded stream are good examples of correlated development. These phases of action are, however, of brief duration.

Taken all together, this is the simplest, most systematic, and most symmetrical example of stream rearrangement that I have yet found. It illustrates to perfection the type of rearrangement that is suffered by streams on denuded coastal plains where an inner longitudinal lowland is enclosed by an upland having a strong inface. This group of sheets is therefore one of the most highly prized in our collection.

THE BAR AND THE AIRE.

Sheets 24, 35.

The Bar is a small stream of very irregular course flowing through a meadow that follows a meandering valley, whose curves have a radius of nearly a mile. The valley bears every mark of having been excavated by a stream that had sufficient volume to flow smoothly around its curves in the fashion followed by the Seine today. The Bar, therefore, appears to be a stream of greatly diminished volume. Ascending its valley southward from its junction with the Meuse, its meandering curves are maintained with almost constant radius, but the volume of the stream progressively diminishes, and at Buzancy the marshy meadow is left without drainage, except such as has been provided by the farmers who have dug ditches between their fields.

Passing still further southward, we come to the Aire, approaching us in a course that leads directly towards the meandering valley of the Bar, but turning sharply to the west near Grand Pré, and in a few miles joining the Aisne, a member of the system of the Seine. The present course of the Aire follows a rather narrow and steep-sided valley that is trenched beneath remnants of a valley plain whose altitude accords closely with the prolongation of the gently ascending meadow-floor of the valley of the Bar. All these things considered, there is every reason to believe that the Aire once followed the valley of the Bar to the Meuse, and that it has been diverted from this path to its present course by the headwater growth of a lateral branch of the Aisne. The probability of this diversion is further proved in two ways: In the first place, the Aire at its junction with the Aisne has a height above sea level of 113 meters; the former mouth of the Aire in the Meuse had an elevation of 153 meters; the former level of the Aire at the point of capture was 182 meters; its present floor at this point is 130 meters. Evidently, therefore, there was good opportunity for the development of a steeper and deeper course by the Aire when the chance came for deserting the system of the Meuse and joining that of the Seine. In the second place, the Fournelle, a small side-branch of the Aisne, now heads close to the Bar, the divide between the two being only six meters above the latter, while the mouth of the Fournelle in the Aisne is 68 meters lower than the Bar. A little further pushing of this divide towards the eastward, and the Bar would be diverted precisely as the Aire has already been.

The meadow that now floors the meandering valley of the Bar has every appearance of having been aggraded; this is a very natural result of the loss of volume in the beheaded stream, which now demands a steeper slope than that which was formerly sufficient.

The head of the Bar is not now immediately adjacent to the elbow where the Aire turns westward, but is eleven kilometers further north; this distance being occupied by a small stream that flows southward to the elbow of capture. The enfeebled

Bar must have been progressively shortened as the south-flowing stream grew headward. While this change must have gone on rapidly for a time following the epoch of capture, its future progress must be extremely slow, because the slopes of the two sides of the divide at the head of the Bar are now not very unsymmetrical.

This set of sheets furnishes the best example of a diminished stream wandering on the aggraded floor of a meandering valley that has come to my notice.

THE COAST OF GASCONY.

Sheets 170, 180, 191, 202, 203, 214, 215.

A great part of the smooth low plain — the Landes — of southwestern France exhibits to a nicety the uncarved initial form of an almost infantile coastal plan of Pleiocene strata. Its surface, seldom cut by streams and marshy in many parts, may be traversed for miles without perceptible inequality. Roads, railways, and property lines follow straight courses for long distances. Where streams occur, they occupy very narrow, steep-sided valleys of slight depth, leaving the broad interstream spaces with very imperfect drainage; once the home of the stilted shepherds.

The harborless coast line of this district, from the mouth of the Garonne southward to the Pyrenees, is of remarkable, indeed of exceptional straightness: for miles together, its departure from a direct line is hardly perceptible. Dunes fringe the whole extent of this even coast, and stretch inland over a belt of from two to four miles wide. Their invasion of the plain has been largely arrested by planting pine trees. The dune barrier effectually encloses the water from a number of the streams, which then collects in sub-triangular lagoons, or *étangs*. One of these, the basin of Arcachon, is supplied by the largest stream of the district, and maintains an open channel to the sea; here the quiet *étang* is replaced by a mud plain that is alternately covered and bared with every run of the tides. It possesses the short, blunt water courses, characteristic of tidal scour on a debatable land surface. It is only where tidal channels of this kind are maintained, breaking across the embankment of dunes, that the shore line shows significant irregularity by bending somewhat seaward.

The surface of the plain is in a very young stage of its life history, but its margin, beaten upon by a stormy sea, must be regarded as more maturely developed. It is just such a flat coast as should have normally been provided with an off-shore bar in the earlier stages of sea attack; but if such a bar ever existed here, it has now been pushed in against and upon the land, the sea bottom deing deepened at the same time, until at present the waves roll in and cut the margin of the plain itself. The prolongation of the slope of the plain does not now coincide with the sea floor; the latter is distinctly below the former (*Reclus*, La France, 103). This satisfactorily illustrates a case of the more rapid advance into the cycle of geographical development under the strong attack of the marginal waves than under the weak action of the superficial drainage; but this is not a constant relation.

The features here illustrated are of a simple kind; but they are of value in preparing the way for a clear understanding of more complicated examples.

GERMANY.

KARTE DES DEUTSCHEN REICHES: Scale, 1–100,000, with hill shading in hachures; sheets 11 x 13 inches; printed in black, except waters in blue. Altitudes of various points in meters.

Sale Agent: R. Eisenschmidt, Neustädtische Kirchstr. 4/5, Berlin, N. W., Germany. Price of sheets, 1.50 marks.

THE VISTULA AND THE NETZE.

Sheets 223, 224, 225, 226, 251, 252, 253, 254.

The Vistula has a sharp elbow or turn in its course from northwest to about north close to Bromberg, some ninety miles south of its mouth. In prolongation of its upper course, but gradually curving to the westward, is a broad-floored valley now occupied by an insignificant stream, the Netze, which comes from a side valley on the south about ten miles west of the elbow at Bromberg. This district has been cited by various authors as offering a good example of the diversion of a river from an old to a new course, leaving the old course to be occupied by a stream that is too small for it; but the cause of the diversion is not clearly stated. It is probably connected in some way with the changes determined by the later phases of glacial action.

On going up the flat valley of the Netze, the plane of its gently ascending floor may be prolonged beyond Bromberg, and discovered again in terraces that now stand somewhat above the present channel of the Vistula. These terraces, like the meadow floor of the Netze, are enclosed by rather well defined slopes that descend from the rolling drift country of the upland. About four miles west of the elbow and close to the town of Bromberg, a small stream, the Brahe, enters the broad-floored valley from a narrow valley on the north. Instead of turning west and joining the Netze, it turns east and, as it were, flows backward to the Vistula, trenching the valley floor slightly on its way. This behavior of the Brahe has very likely resulted from the formation by it of a flat alluvial fan on the broad floor of the Netze trough; such a fan being the characteristic product of a side stream that enters a broad valley deserted by the master stream. With the growth of the fan across the Netze trough, the Brahe has there formed a flat divide, and, happening to run down the eastern slope of the fan, it found its way to the Vistula instead of maintaining a connection with the Netze, as it must have done for a time after the diversion of the greater river to its new course.

It is important to note that the breadth of the Netze trough is not alone a sufficient reason for arguing that it cannot have been formed by a small stream; for small streams may, in time, form broad valleys. But if the Netze had formed the broad valley, all the other small streams of the region should also flow in broad valleys, and this is by no means the case. Not only the Brahe from the north and the Netze from the south, but also the Lobsonka from the north, all occupy comparatively narrow valleys. The Netze, therefore, evidently did not excavate the broad trough that it follows. Furthermore, the sides of this trough are on the whole rather sharply cut, as if by a powerful stream that frequently impinged on one or the other side, and not at all as if the valley had been widened by the slow action of a small stream. A pertinent account of this region may be expected in a promised essay on the ancient rivers of North Germany, by Berendt, in a forthcoming number of the Forschungen zur Deutschen Landes und Volkskunde.

THE ENCLOSED BAYS OF THE BALTIC.

Two groups: sheets 28, 48, 49, 71, 72, 73; and 1, 3, 8, 15, 16, 29, 30.

On the southeastern side of the Baltic there are two bays known as the Frische (Frisian) and the Kurische, for the latter of which we have no ordinary English equivalent. The bays appear to be a product of the moderate submergence which this region has suffered, whereby its marginal lowlands and valleys have been flooded. At present both bays are enclosed by long curving sand-bars, and the original irregularity of the shore line has thus been greatly simplified. These bars are known as *Nehrungen*, a word that does not appear in the usual German dictionary. They are built up to heights of eighty or one hundred, or even one hundred and eighty feet, by great sand dunes whose trend indicates the control by westerly winds. Both of the bars appear to have grown from southwest to northeast, as the end of the bars is now pushed far up towards the northern side of the bays. The curvature of the bars is, on the whole, remarkably smooth, but of greater inequality than that observed on similar bars on our Atlantic or Gulf coast, where the movement of the sea is much stronger than in the Baltic. The outlets of both bays are now protected by jetties in order to prevent their shoaling by drifting sand. The enclosed waters being shallow and quiet, the streams entering the bays form minutely digitate deltas, thus illustrating their control by stream intention. Similar streams entering a more active sea would be relatively less competent to carry out their intention, and there the deltas would be smooth and simple. The best of these deltas is that of the Nogat, a distributary of the Vistula, which enters the Haff at its southwestern end. An elaborate account of the Kurische Haff has been written by Berendt (Schr. Phys. Oek. Gesell. Königsberg, IX, 1868), and a general account of the Kurische Nehrung may be found in the essay by Bezzenberger in the Forschungen zur Deutschen Landes- und Volkskunde (Vol. III).

THE VALLEY OF THE MIDDLE RHINE.

Sheets 526, 527, 543, 544, 557, 558, 572, 573.

The long depression which the Rhine follows between the Vosges on the west and the Black Forest on the east is explained by German geologists as a *Graben*, produced by the downfall of a long block of country between the uplifted old mountain masses on either side.[1] During the depression of the block, the Rhine does not appear to have been converted into a lake, for borings in the valley floor do not reveal lacustrine sediments, but pass through gravels and sands to a considerable depth. It is therefore concluded that the Rhine aggraded its course and maintained itself as a river during the time of deformation.[2] When this is taken in connection with the next example, it will be seen that the Rhine in this portion of its course must be regarded as a very successful antecedent river, neither being laked where its floor was depressed nor turned aside where its floor was uplifted.

The border of the valley is remarkably well defined north and south of Heidelburg, and for a considerable distance about opposite these points on the west; but only the medial portion of this low ground has the features of a river flood plain. On either side, and particularly on the west, the valley floor slopes from the margin towards the center and these slopes are trenched to a slight depth by streams that come out from the mountains; but along the middle belt the earlier and later meanders of the Rhine have developed a broad flood plain of well-defined features. The scars of old meanders are still visible in ox-bow lakes, in curved strips of marsh, and in crescentic depressions slightly beneath the general level of the plain, always convex away from the river, and of radius equivalent to that of existing meanders. These slight inequalities of form suffice to determine the position of many roads and property lines. Through most of this plain the Rhine now flows in a "regulated" channel, much less meandering than its natural path.

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[1] LEPZIUS: Die Oberrheinische Teifebene und ihre Randgebirge, Forsch. z. deut. Landes- u. Volkskunde, I, 1885, 35–91.

[2] PENCK, in Kirchhoff's Länderkunde des Erdtheils Europa, I, 1887, 232, 318.

The Necker, which now enters the Rhine at Mannheim almost directly opposite its emergence from the mountains at Heidelberg, formerly ran northward along the east side of the plain to Zwingenberg and then obliquely across the plain almost to Mainz before entering the Rhine. The faint scars of its old meanders are traceable for nearly all this distance. These scars are distinguished from those of the Rhine by their small radius of curvature.

THE GORGE OF THE RHINE.

Sheets 458, 459, 483, 484, 505, 506, 525, 526.

The gorge of the Rhine from Bingen to Coblenz, where the Moselle enters from the west, is deeply trenched beneath the uplands of the Schiefergebirge; the Hunsrück on the west and the Taunus on the east. These uplands possess, as a whole, a very moderate inequality; they are in great part occupied and cultivated. Here and there linear ridges of quartzite and other resistant rocks maintain a distinct relief above the general level, forming the Idarwald, Soonwald, Rheingau, etc. Extended views may be obtained from their summits over the surrounding country. One of these points, the Katzenkopf (653 m.), near the village of Rheinbollen, discloses a particularly fine panorama on all sides.

These uplands are among the best examples that I have seen of worn-down mountains, now lifted and slightly dissected, but still retaining over broad areas the form to which they had been reduced while they yet stood close to the former baselevel of the region. The Rhine has cut its gorge directly across the uplands, and when this is taken in connection with its behavior on the open valley further south, it indicates very clearly the existence of the Rhine as a river antecedent to the differential movements by which the broad outlines of the present geography were determined.

That the Rhine actually flowed across the country that is now raised to an upland position is demonstrated by a more minute study of the form of its present valley; this study being made, however, much more easily on the ground than by means of the maps. A broad trough is sunk to a depth of about a hundred meters beneath the general level of the upland. On the floor of this trough is a level deposit of loess lying upon water-worn shingle, which in turn rests upon the bedrock. The present gorge of the Rhine is a narrow trench that is incised about 250 meters beneath the loess-covered floor of the trough. The path of the Rhine in its gorge is much less sinuous than that of the Moselle on the west and the Lahn on the east. It is possible that this difference of behavior may be explained as the result transverse course of the larger river, and of the longitudinal courses of its side branches. During the former cycle of denudation the longitudinal streams would generally have had wider valleys and better chances to meander on their floors than the transverse Rhine could have had; and the result of their former meandering on flat valley floors is now seen in the meandering path of their steep-sided gorges.

Following the lead of the larger rivers, the smaller side streams are actively at work dissecting the upland; but as yet they have seldom made much progress in their work. It is noticeable that upon the uplands of the Hunsrück three streams now flow south or southeast through the residual ridges of the Soonwald on their way to the Nahe and the Rhine, thus suggesting an inheritance of their headwaters from geographic conditions long since vanished. Note should also be made of the antecedent course of the Nahe through the spur of the upland just back of Bingen.

THE GORGE OF THE MOSELLE.

Sheets 502, 503, 504, 522, 523, 524, 539, 540, 541.

The Moselle from Trier to Coblenz follows a deep and, for the most part, narrow and steep-sided valley, by which the upland of the Hunsrück is separated from that of the Eifel. Through the greater part of its course, the valley has a very strongly meandering habit, thus repeating the behavior of the lower Seine. In this case, however, there is fuller demonstration of the inheritance of the existing incised meanders from the normal meanders of the river when it was flowing on a broad-floored valley in an earlier cycle of denudation. The upland through which the Moselle flows is composed of greatly disturbed rocks which form part of the ancient Hercynian mountain system, stretching from the Ardennes northeast into Germany. Nearly all traces of mountain form was, however, lost in the long cycle of denudation in which the even uplands were produced; occasional ridges, like the Hochwald and Soonwald, alone remaining. At the close of that cycle the Moselle must have earned the right to meander as freely as it choose. The present meanders, it can hardly be doubted, are inherited from those early ones. The inheritance, however, is that of a third generation; for here, as in the case of the Rhine, the trench of the Moselle is sunk beneath a flat-floored trough, which, in turn, is excavated below the general level of the uplands. The existing meanders must therefore be regarded as following those that were developed upon the floor of the trough, while the trough meanders followed those that had been still earlier developed on the upland when it was a lowland. In the neighborhood of Berncastel, the necks of some of the spurs that enter the meanders have been reduced to a very narrow measure; in one case, the railroad that generally follows the river banks shortens its course by tunnelling through the neck of the spur. Just above Berncastel, the narrowing of the necks of the ancient spurs has been carried still further, and two of them are cut through by the river; the abandoned meanders being now distinctly traceable in flat meadows that curve around the isolated extremities of the spurs. Sheets 503, 504 include several of the *maare* in the volcanic district of the Eifel.

These and other grouped sheets have been so instructive and profitable, both in studying and teaching, that I urge their use upon students and teachers of physiography in normal schools and colleges. They furnish numerous examples of well defined physiographic features, and thus serve to extend the fund of geographical types and illustrations far beyond the narrow limits within which the subject is usually carried forward from early school years. On some future occasion I hope to present briefer notes on a larger series of grouped sheets, to give further indication of the richness and variety of easily accessible material of this kind.

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